REMARKS/ARGUMENTS

Claims 1 and 6-14 are pending. By this Amendment, claims 2-5 are cancelled, claim 1 is amended, and new claims 6-14 are presented. Support for new claims 6-14 and the amendments to claim 1 can be found, for example, in the present specification at page 2, line 12 to page 7, line 4, and in original claims 1-5. No new matter is added. In view of the foregoing amendments and following remarks, reconsideration and allowance are respectfully requested.

Rejection Under 35 U.S.C. §102

The Office Action rejects claim 1 under 35 U.S.C. §102(b) over U.S. Patent No. 5,132,749 to Nishibayashi et al. ("Nishibayashi"). Applicants respectfully traverse the rejection.

By this Amendment claim 1 is amended to incorporate, e.g., the subject matter of claim 5, which is not subject to this rejection. Accordingly, amended claim 1 distinguishes over Nishibayashi.

Claim 1 is not anticipated by Nishibayashi. Accordingly, reconsideration and withdrawal of the rejection are respectfully requested.

Rejection Under 35 U.S.C. §103

A. Nishibayashi

The Office Action rejects claims 2-4 under 35 U.S.C. §103(a) over Nishibayashi. By this Amendment, claims 2-4 are cancelled, rendering the rejection moot. Moreover, as discussed above, by this Amendment claim 1 is amended to incorporate, e.g., the subject matter of claim 5, which is not subject to this rejection. Accordingly, amended claim 1 distinguishes over Nishibayashi.

B. Nishibayashi and Valone

The Office Action rejects claim 5 under 35 U.S.C. §103(a) over Nishibayashi in view of U.S. Patent No. 5,602,439 to Valone ("Valone"). By this Amendment, claim 5 is cancelled, rendering the rejection moot. However, amended claim 1 recites the subject matter of claim 5. Accordingly, Applicants provide the following comments, explaining why amended claim 1 distinguishes over Nishibayashi and Valone.

Claim 1 recites "[a] method of forming a film of boron doped diamond for an electrode used in an electrolytic apparatus, the method comprising: forming a first diamond film on a graphite substrate at a high film-formation rate by supplying a mixed gas of hydrogen, a boron source and methane, the methane being present at a concentration of from 1 to 10%; and forming a second and outermost diamond film on the first diamond film at a low film-formation rate by supplying a mixed gas of hydrogen, a boron source and methane, the methane being present at a concentration of not more than 0.3%; wherein: each of the first diamond film and the second and outermost diamond film is formed by a hot filament CVD process or a microwave plasma CVD process; the first diamond film comprises a low-quality diamond having impurities of amorphous carbon or graphite; the first diamond film has a thickness of not less than 5 μm; the second and outermost diamond film comprises a high-quality diamond film having substantially no impurities of amorphous carbon or graphite; and the second and outermost diamond film has a thickness of not more than 1 μm" (emphasis added). Nishibayashi and Valone do not disclose or suggest such a method.

The Office Action relies on Nishibayashi for its alleged disclosure of a method of forming a diamond electrode including using a CVD process employing a mixed gas of a carbon source and hydrogen to form a diamond film, including a high purity outermost diamond film, on a substrate. *See* Office Action, page 2. The Office Action concedes that

Nishibayashi does not disclose forming a diamond film on a graphite substrate, but asserts that it would have been obvious to do so, in view of the teachings of Valone. *See* Office Action, page 2. Notwithstanding these assertions, Nishibayashi and Valone would not have rendered claim 1 obvious.

At the outset, Applicants note that Nishibayashi fails to disclose several aspects of the method of claim 1. For example, Nishibayashi fails to disclose: (i) a method of forming diamond film for electrodes used in an electrochemical process, (ii) forming a diamond film on a graphite substrate, (iii) forming a first low quality diamond film with graphite impurities at a high film-formation rate, and (iv) forming a second high quality diamond film doped with a boron source at a low film-formation rate using a methane concentration lower than 0.3%. Likewise Valone fails to disclose several aspects of the method of claim 1. For example, Valone fails to disclose: (i) a method of forming diamond film for electrodes used in an electrochemical process, (ii) forming a first low quality diamond film with graphite impurities with a thickness of 5 μm or more, (iii) forming a first low quality diamond film with boron doping, and (iv) forming a second high quality diamond film doped with a boron source at a low film-formation rate.

As is evident from the lists above, there is overlap in the deficiencies of Nishibayashi and Valone. As neither Nishibayashi nor Valone discloses forming a first diamond layer and a second diamond layer in the manner and having the attributes recited in claim 1, the combination of references fails to disclose or suggest each and every feature of claim 1.

Nishibayashi does not disclose a method for forming diamond films for electrodes used in electrolytic apparatus as recited in claim 1. Nishibayashi, by contrast, discloses a method for forming diamond films for p-n junction or Schottky junction diodes. *See* Nishibayashi, Abstract. Such diodes operate to rectify alternating electrical currents by preventing reverse current flow. This function has wide applications in the semiconductor

and electrical industries. Nishibayashi discloses providing an intermediate non-doped or low-doped diamond layer with thickness of 1 nm to 1 mm between p-type and n-type doped semiconductor diamonds composing a p-n junction or between a doped semiconductor diamond and a metal form a Schottky junction, to avoid doping-induced crystal disorder. *See* Nishibayashi, column 3, line 66 to column 4, line 58. A non-doped diamond is an insulator with high resistivity. *See* Nishibayashi, column 3, lines 14 to 15. The Office Action's reliance on Nishibayashi relies on the fact that Nishibayashi discloses a structure including a non-doped diamond layer or low-doped diamond layer over a doped diamond layer.

In the method of claim 1, boron doped diamond films are used to form diamond electrode used to generate OH radicals by electrochemical process – for example, in water and waste liquid treatment. *See, e.g.,* present specification, page 1, lines 5 to 15. Neither of the diamond layers specified in claim 1 is non-doped diamond layer or a low-doped diamond layer with insulating or high-resistivity properties. As would be apparent to one of ordinary skill in the art, if a diamond electrode for an electrochemical process has insulating or high-resistivity properties, the electrode will cause an increase in the potential applied to the electrode. Employing an insulating diamond layer could possibly render an electrode useless in an electrochemical application. Direct currents are applied to electrolytic apparatus, not alternating currents as in the diodes of Nishibayashi. One of ordinary skill in the art would not have been motivated to modify the method of Nishibayashi as would be required to satisfy claim 1.

The impurities in the first diamond layer of claim 1 include, e.g., graphite, amorphous carbon and substrate carbide impurities. *See, e.g.,* present specification, page 6, lines 8 to 11. An impurity, as recited in claim 1, is different from a dopant, which is necessary to form a conductive diamond film. The high quality and low quality diamond films of claim 1 are doped with a boron source. The process of claim 1 employs a mixed gas including hydrogen

gas, a carbon source and a slight amount of boron source as a dopant. The concentration of methane gas is used to control the quality of the respective diamond films. High methane concentration increases the film formation rate and allows impurities of graphite and amorphous carbon to form. *See* present specification, page 6, lines 11 to 17. Forming a first layer including graphite impurities on a graphite substrate is not detrimental, but rather improves the adhesion of the first diamond film to the substrate and reduces the layer stress resulting from the difference in the thermal expansion between the first diamond layer and the graphite substrate. *See* present specification, page 7, lines 15-21. Nishibayashi does not remotely disclose or suggest forming an electrode having such a structure.

Applicants further note that the "electrodes" described in Nishibayashi are not diamond layers, but rather metal that contacts such diamond layers. *See, e.g.,* Nishibayashi, column 7, lines 31 to 39. The diamond electrode in claim 1 is an electrode for electrochemical reaction, which includes the entire recited structure including the substrate, the low quality first diamond film and the high quality second diamond film.

Valone discloses diamond coated-graphite composites for electron emitters and not diamond electrodes, as recited in claim 1. *See, e.g.,* Valone, column 3, lines 9 to 20. The voltages applied to electron emitters may be on the order of 3kV. *See, e.g.,* Valone, column 6, line 28. Diamond electrodes for electrolytic applications, such as those formed by the method of claim 1, are subjected to tens of volts. As a result, Valone employs different method steps to form the disclosed structures. The diamond films in Valone are non-doped (*see* column 6 lines 5 to 13) or doped with nitrogen or phosphorus (*see* column 4, lines 12-23) to form an n-type semiconductor diamond film. On the other hand, the diamond films of claim 1 are boron doped, so a p-type semiconductor diamond film is formed. Also, while the diamond films in Valone may be formed on graphite substrates and include impurities (as in the first diamond film in claim 1), the films are formed to thicknesses of less than 5 μm, and

preferably as thin as possible, to form electron emitters. *See* Valone, column 4, lines 54 to 62. The thicker layer employed as the first diamond layer in claim 1 (not less than 5 μm) disperse forces applied to the film and increase the strength of the film. *See, e.g.*, present specification, page 3, lines 6 to 13.

The thicker first diamond film of claim 1, which may include large amounts of graphite and amorphous carbon, demonstrates improved adhesion performance to a graphite substrate and reduces residual stress due to the differences in thermal expansion coefficients of the diamond layer and the graphite substrate. *See* present specification, page 7, lines 15 to 21. Because the first diamond layer in claim 1, which contains graphite impurities, is chemically weak against corrosion caused by the OH radical attack during an electrolysis process, a protective thin second layer of high quality diamond is formed. To prepare this protective layer, the second diamond film is formed at slower rate. *See* present specification, page 4, lines 19 to 24. In Valone, the outermost surface has graphite impurities and a boron source is not added. *See* Valone, column 4, line 63 to column 5, line 4. Valone does not remotely disclose or suggest forming an electrode as recited in claim 1.

Applicants further note that Valone discloses that it is not easy to coat a graphite substrate with diamond due to the etchings of the graphite material by atomic hydrogen. *See* Valone, column 3, lines 47 to 58. In claim 1, by high methane concentration in the presence of boron permits rapid diamond film formation on graphite, a feature not disclosed or suggest by Valone.

For at least the reasons discussed above, Nishibayashi and Valone fail to disclose or suggest each and every feature of claim 1 and one of ordinary skill in the art would not have looked to the disparate teachings of Valone to modify the device of Nishibayashi, which has entirely different requirements and is put to an entirely different use. A *prima facie* case of obviousness cannot be made.

Claim 1 would not have been rendered obvious by Nishibayashi and Valone. Accordingly, claim 1 is believed to be allowable.

New Claims

By this Amendment, new claims 6-14 are presented. New claims 6-14 depend from claim 1 and, thus, are believed to be patentable for at least the reasons discussed above with respect to claim 1.

Conclusion

For the foregoing reasons, Applicants submit that claims 1 and 6-14 are in condition for allowance. Prompt reconsideration and allowance are respectfully requested.

Respectfully submitted,

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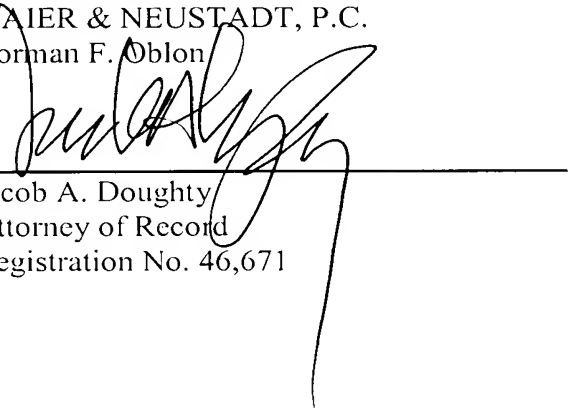

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